

Molecules and Covalent Bonds

Chemistry in Our World
Kent State University Stark Campus

Overview of Lecture

- Classify compounds based on elements
- Show bonding in simple molecules
- Drawing structures of molecules

Covalent Compounds

Covalent Compounds also called:

- Molecular compounds
- Non-metallic compounds

Formed from combination of non-metals

Types of Elements

The periodic table is shown with a vertical line separating metals from non-metals. Elements to the right of the line are highlighted in green and labeled 'Non-metals'. Elements to the left are highlighted in yellow and labeled 'Metals'. The noble gases (He, Ne, Ar, Kr, Xe, Rn) are also highlighted in green.

| | | | | | | | | | | | | | | | | | |
|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|
| H | | | | | | | | | | | | | | | | | He |
| Li | Be | | | | | | | | | | | B | C | N | O | F | Ne |
| Na | Mg | | | | | | | | | | | Al | Si | P | S | Cl | Ar |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe |
| Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn |
| Fr | Ra | Ac | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | | | | | | | |
| | | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | | |
| | | Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr | | |

Binary Compounds

1) Classify each of two elements as:

Metal or **Non-metal**

- **Metal + Metal → Metal**
- **Non-metal + Non-metal → Non-metal**
- **Metal + Non-metal → Ionic**

Covalent Bonds

Covalent/Molecular compounds held together by **Covalent Bonds**.

- A Covalent bond is a sharing of electrons. (All atoms contain electrons).
- Each atom has an **ideal** number of bonds that it wants. We can determine this value from the periodic table.

Ideal Number of Covalent Bonds

| | | | | |
|--|----|----|----|----|
| | | | 1 | 0 |
| | 4 | 3 | 2 | H |
| | C | N | O | F |
| | Si | P | S | Cl |
| | | As | Se | Br |
| | | | | He |
| | | | | Ne |
| | | | | Ar |
| | | | | Kr |

Diatomic Molecules

Diatomic Molecules contain 2 atoms.

- H_2 : H—H
- Br_2 : Br—Br
- HCl: H—Cl

Multiple Bonds

For some molecules, more than one bond is needed between atoms.

- O_2 : O=O Double bond
- N_2 : $N \equiv N$ Triple bond
- C_2 : **NO!!** Quadruple bonds don't occur.

Water

- Oxygen (O): 2 bonds
- Hydrogen (H): 1 bond
- H_2O

*Too Many
Bonds on H*

WRONG!



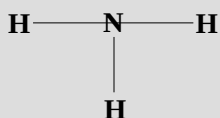
*Not Enough
Bonds on O*

Correct



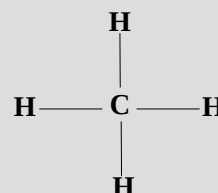
Ammonia

- Nitrogen (N): 3 bonds
- Hydrogen (H): 1 bond
- NH_3



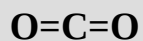
Methane

- Carbon (C): 4 bonds
- Hydrogen (H): 1 bond
- CH_4



Carbon Dioxide

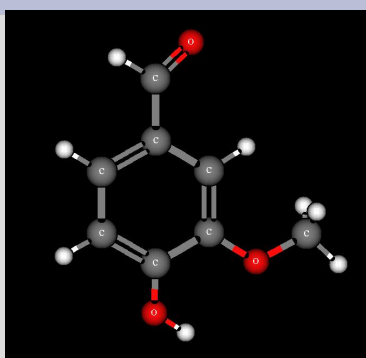
- Carbon (C): 4 bonds
- Oxygen (O): 2 bonds
- CO₂



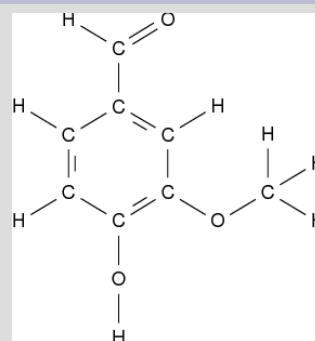
Representations of Molecules

- Computer-generated
 - May be interactive (3D)
- Lewis
 - shows all atoms
- Stick
 - Convenient for large organic molecules

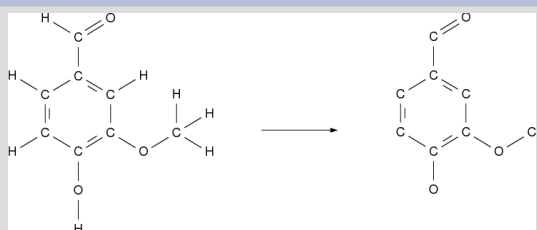
Vanillin



Vanillin - Lewis



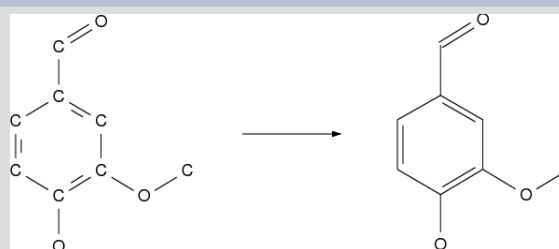
Drawing Stick Structures



Start with
Lewis Structure

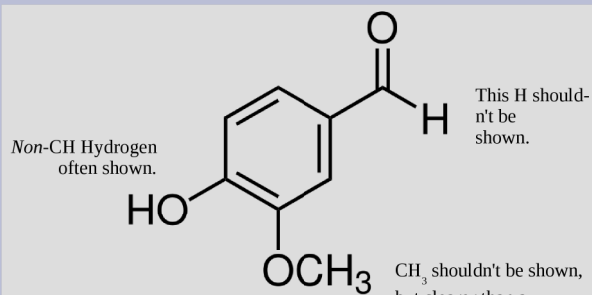
Remove all H atoms
and Bonds to H

Drawing Stick Structures (cont.)

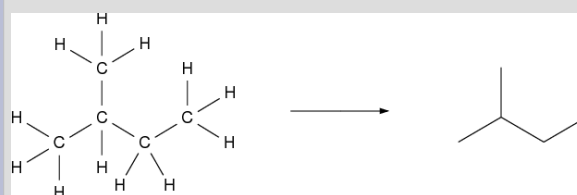


Remove all C atoms, but keep bonds

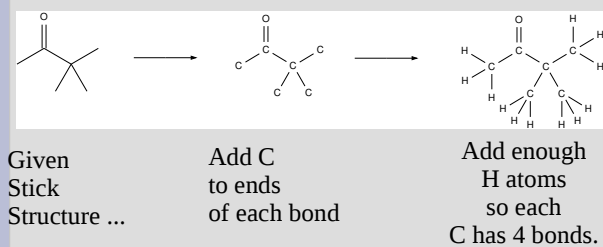
Vanillin – Modified Stick



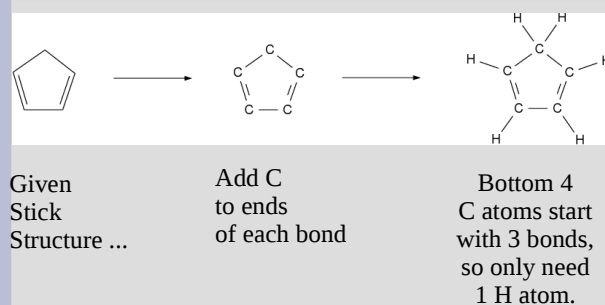
Isopentane



Stick to Lewis



Multiple Bonds



Summary

- Classify elements → Classify compound
- **Covalent:** Use ideal bonding numbers to determine formula and structure
- **Stick Structures:** Useful for large organic molecules and rings.